IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

SATO et al. Anticipated Art Unit: 1765

Application No. Unknown Anticipated Examiner: R. Kunemund

Filed: November 14, 2001 Atty. Docket No. 107242-09013

For: QUARTZ GLASS CRUCIBLE FOR PULLING UP SILICON SINGLE CRYSTAL AND PRODUCTION METHOD THEREFOR

PRELIMINARY REMARKS FOR CONTINUATION APPLICATION

Assistant Commissioner for Patents
Washington, D.C. 20231

November 14, 2001

Sir:

Prior to Examination of this Continuation Application, the Examiner is kindly requested to consider the following remarks. An Office Action dated June 14, 2001 was received in the parent application, Application No. 09/462,097. It was responded to by way of An Amendment under 37 C.F.R. 1.116 which was not entered. The claims of this continuation application have been prepared to place them in the identical posture as if the amendment had been entered and prosecution continued.

The Office Action rejected parent application claims 1-7 under 35 U.S.C. § 103(a) as unpatentable over Uchikawa et al. (EPO 319 013) in view of Matsumura et al. (EPO 463 543). The only current equivalent claims are claims 4 - 8 (parent 3 and 5 - 7).

Uchikawa teaches a quartz glass crucible that is used in a process for pulling a single crystal semiconductor material. The quartz glass crucible has an opaque outer substrate of a quartz glass with a relatively high bubble content and an inner transparent glass layer which is substantially free from bubbles. The crucible has a

substantially bubble-free transparent glass layer even after it is used for a pulling process.

Matsumura also teaches a quartz glass crucible that is used in the manufacture of a silicon single crystal. Matsumura further teaches that the quartz glass crucible has an outer layer which contains less than 0.3 ppm of each Na, K and Li and more than 5 ppm of Al. The outer layer also contains bubbles that present an opaque appearance. The inner layer is made by melting powders of high purity non-crystalline synthetic silica and contains less than 200 ppm of OH-group.

Claim 4 has been rewritten to depend from Claims 1 - 3 (parent newly-added claims 26-28).

The Office Action rejected parent claims 15-25 under 35 U.S.C. § 103(a) as unpatentable over Uchikawa in view of Matsumura and Sato et al. (U.S. Patent No. 5,989,021). The equivalent current claims are claims 8 -18.

Sato teaches a quartz crucible with a large inner diameter for pulling up a silicon single crystal.

Claims 8 -13 are rewritten to depend from claim 4 (parent claim 3).

Claims 14 - 18 (parent claims 21-23) are directed to a production method for a quartz glass crucible for pulling up a silicon single crystal. The quartz glass crucible has a diameter. With an arc rotation melting method, a base body is prepared in a mold using silicon dioxide powder and an inner layer is formed on an inner surface of the base body using silicon dioxide powder under conditions that the silicon dioxide powder has a particular gas content and an OH-group concentration equal to or less than 300 ppm, a heat melting power, a horizontal distance from an arc center to a falling position of the

silicon dioxide powder is in the range of 50-300 mm. A distance from the arc center to an inner surface of piled-up powder on a bottom surface of the base is equal to or less than a particular distance, a particle diameter of the silicon dioxide powder is equal to or less than 300 μm, and a feed rate of the silicon dioxide powder is equal to or less than 200 g/min.

In claims 14 and 15, the diameter of the quartz glass crucible is in a range of 22 to 28 inches. In claim 16, the diameter of the quartz glass crucible is in a range of 30 to 48 inches.

In claims 14 and 16, the gas content is equal to or less than 30 μl/g while in claim 15 the gas content is equal to less than 20 μl/g.

In claim 14, the heat melting power is applied in a range of 400 to 1000 kw. In claim 15, the heat melting power is applied in a range of 200 to 400 kw. In claim 16, the heat melting power is applied in a range of 600 to 2000 kw.

In claims 14 and 15, the distance from the arc center to an inner surface of piled-up powder on a bottom of the base body is equal to or less than 800 mm. In claim 16, the distance from the arc center to an inner surface of piled-up powder on the bottom of the base body is equal to or less than 1500 mm.

It is respectfully submitted that none of the applied art, alone or in combination, teaches or suggests the features of claims 14 - 18. Specifically, none of the applied art teach or suggest a particular gas content, an OH-group concentration, a heat melting power, a horizontal distance from an arc center, a distance from an arc center to an inner surface of piled-up powder, a particle diameter of the silicon dioxide powder and a feed rate of the silicon dioxide powder. Thus, one of ordinary skill in the art would not be motivated to combine the features of the applied art. Assuming, *arguendo*, that one of

ordinary skill in the art would be motivated to combine the features of the applied art, such combination of features of the applied art would not result in the claimed invention.

It is respectfully submitted that Claims 1 - 3 (parent newly-added claims 26-28) also include features not shown in the applied art. In brief, these claims incorporate the features of parent claims 5-7 into parent claim 1 to yield three independent claims. Claims 1 - 3 are directed to a quartz glass crucible for pulling up a silicon single crystal. The quartz glass crucible of these claims include a crucible base body constituted of a semi-transparent quartz glass layer and a transparent quartz glass layer formed on an inner wall surface of the crucible base body characterized in that no expanded bubbles equal to or more than 0.5 mm in diameter are present in a layer 1 mm in depth from an inner surface of the quartz glass crucible after the silicon single crystal is pulled up using the quartz glass crucible. With an arc rotation melting method, the base body is prepared in a mold using a silicon dioxide powder and an inner layer is formed on an inner surface of the base body using silicon dioxide powder under conditions that the silicon dioxide powder has a particular gas content and an OH-group concentration equal to or less than 300 ppm, a heat melting power of a specific range, a horizontal distance from an arc center to a falling position of the silicon dioxide powder in range of 50 to 300 mm, a distance from the arc center to an inner surface of piled-up powder on a bottom of the base body is equal to a set number of millimeters, a particle diameter of the silicon dioxide powder is equal to or less than 300 μm and a feed rate of the silicon dioxide powder is equal to or less than 200 g/min.

In claims 1 and 3, the gas content is equal to or less than 300 μl/g while in claim 2 the gas content is equal to or less than 20 μl/g. The heat melting power is applied in

a range of 400 to 1000 kw in claims 1 and 2; while in claim 3 the heat melt power is applied in a range of 600 to 2000 kw. In claims 1 and 2, the distance from the arc center to an inner surface of the piled-up powder on a bottom of the base body is equal to or less than 800 mm while in claim 3, the distance is equal to or less than 1500 mm.

It is respectfully submitted, although Uchikawa states "substantially free from bubbles", bubbles actually exist even after the crucible is used for the pulling up process.

Neither Uchikawa nor Matsumura clearly teach a condition of bubbles at the inside of the crucible after pulling up. The claimed invention basically is focused on "bubbles expansion" at the inside of a crucible after the crucible is used for the pulling up process. Bubble expansion cannot be determined by only size and temperature. When an equilibrium value of a pressure from the outside (quartz glass), molecular weight, activation energy and so on exceed a critical value, bubbles expand. However, bubbles shrink when they are below a critical value.

Moreover, selection of a gas content significantly influences bubble expansion. Some gas is likely to gasify by the reaction with quartz glass while some gas is soluble to liquid phase quartz glass. For example, carbon reacts with quartz glass to form a gas such as CO. On the other hand, gas such as oxygen, chlorine or the like, since their solubility is low and their molecular diameter is large, will hardly diffuse into quartz glass, so that bubbles are expanded. If OH is concentrated at a high level in material powder, since the amount of oxygen increases as a result of the reaction, it causes bubbles.

Indeed, from the above point of view, the claimed invention which defined the

content and kind of gas can be clearly distinguishable from Uchikawa et al. which defined only the number and size of bubbles because these inventions were made from a technically different point of view. Matsumura also does not teach any gas content. The present specification is the very first one which recites the data regarding the gas content at the transparent inside layer.

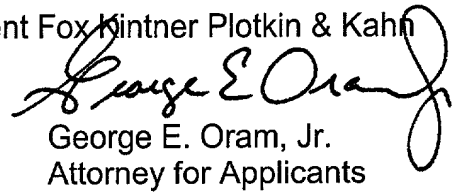
Consequently, for all of the above reasons, the claimed invention would not have been obvious to a person of ordinary skill in the art at the time the invention was made.

In view of the foregoing, consideration of this continuation application and allowance of the pending claims are respectfully solicited. Should the Examiner believe anything further is desirable in order to place the application in even better condition for allowance, the Examiner is invited to contact Applicant's representative at the telephone number listed below.

In the event this paper is not being timely filed, the applicant respectfully petitions for an appropriate extension of time. Any fees for such an extension together with any additional fees may be charged to Counsel's Deposit Account 01-2300.

Respectfully submitted,

Arent Fox Kintner Plotkin & Kahn



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